United States Patent [19]

James

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[54] **HEAT SENSITIVE NOVELTY DEVICE**

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[21] Appl. No.: **189,188**

[52] **U.S. Cl.** ..... **161/5**, 23/230 LC, 40/28 R, 161/6, 161/139, 161/DIG. 5, 161/410, 252/408, 350/160 R

[51] **Int. Cl.** **B44f 9/08**, B01j 13/02

[58] **Field of Search** ..... 252/408; 161/1, 3.5, 5, 161/6, 139, DIG. 1, DIG. 5, 408–410; 350/160 LC; 23/230 LC; 40/28 C, 28 R

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Primary Examiner—Harold Ansher
Attorney, Agent, or Firm—John J. Leavitt

[57] **ABSTRACT**

A novelty device which utilizes the iridescing qualities of liquid crystalline material to effect variations in colorations of the device upon application of different temperatures.

7 Claims, 9 Drawing Figures

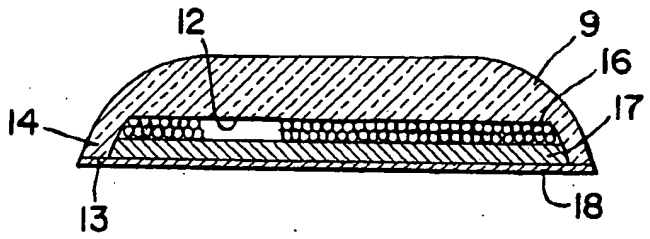

FIG. 1.

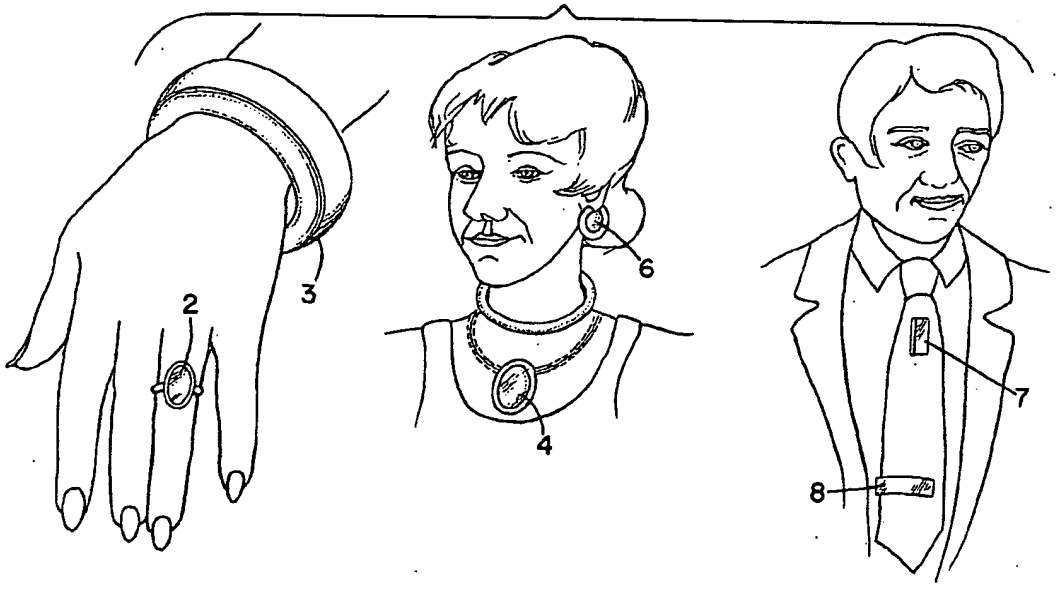

FIG. 2.

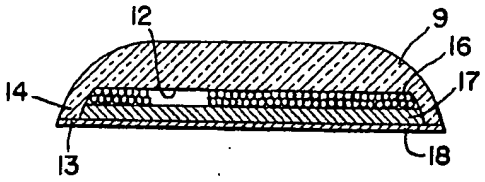

FIG. 3.

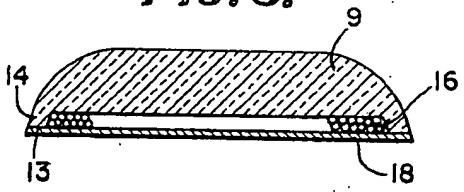

FIG. 4.

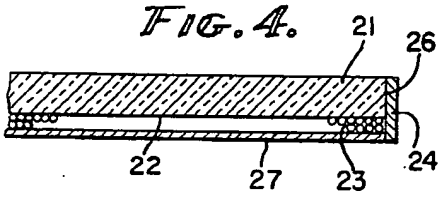

FIG. 5.

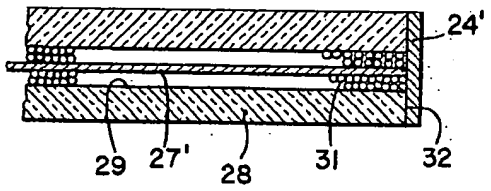

FIG. 6.

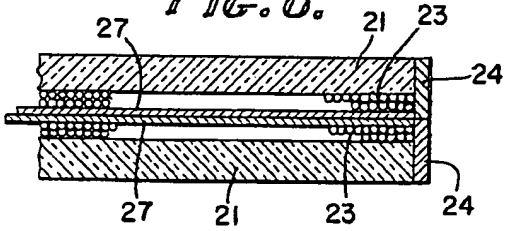

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FIG. 7.

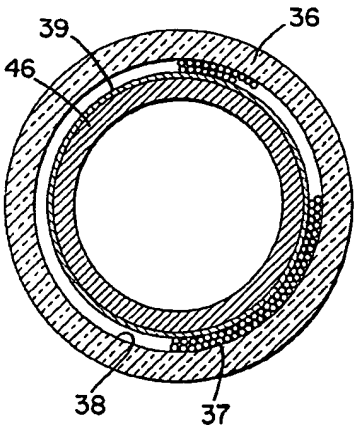


FIG. 8.

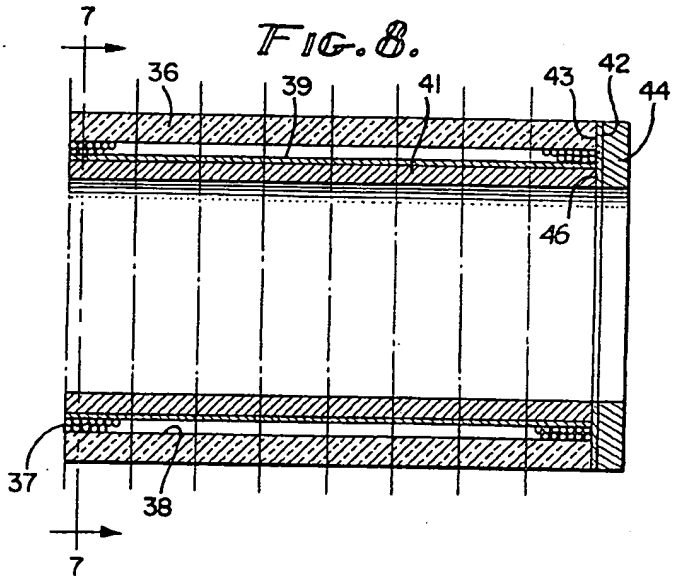
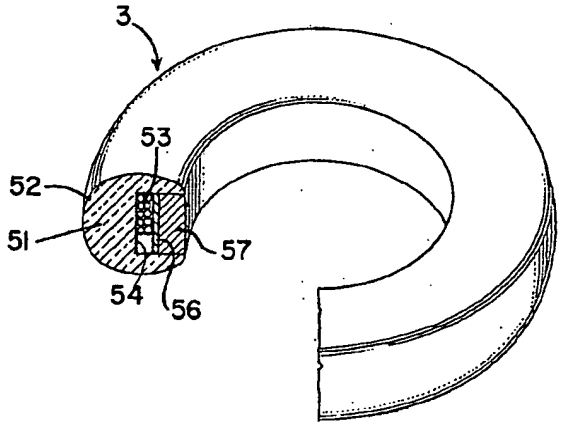


FIG. 9.



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HEAT SENSITIVE NOVELTY DEVICE

BACKGROUND OF THE INVENTION

This invention relates to novelty devices fabricated from transparent synthetic resinous materials in combination with crystalline liquids such as those described in U.S. Pat. No. 3,524,726 and British Patents 1,138,590 and 1,161,039. These patents each teach the characteristic of crystalline liquids of various types, sensitive to various temperatures, to provide iridescence in the crystalline liquid, such iridescence being useful for several different purposes. As indicated in British Patent 1,138,590, the usefulness of cholesteric mesomorphs in temperature-sensitive systems has been severely limited due largely to the fact that these crystalline liquids had not theretofore been isolated. This patent teaches a method by which tiny droplets of crystalline liquids, described in this patent as thermotropic liquids, are isolated and protected as the cores of minute transparent walled capsules, and the subsequent distribution of these capsules in a thin film layer on a suitable substrate, preferably sensitive to temperature variations. The wall of the capsule which contains the liquid nucleus of crystalline liquid material is transparent, i.e., transmits light incident upon and reflected from the capsule contents. It has been found that many of the disadvantages inherent in the use of these mesomorphic compound film layers in the wet state disappear when used in the form of tiny encapsulated droplets.

Although each of the tiny droplets is itself encapsulated, it has been found through tests and experimentation that such encapsulated droplets are still subject to destruction by contact with various solvents, excessive heat, and physical abrasion. Accordingly, it is one of the principal objects of the present invention either to encapsulate a multiplicity of such encapsulated droplets, in strip form for use in the ulitmate product, or to encapsulate a quantity of the encapsulated droplets by the formation of the end product itself.

It has been found that additional encapsulation of the encapsulated droplets of crystaline material can be effected in such a way that the finished product may be used for many different purposes, for instance, as the setting for a ring, a pendant, a tie clasp, or a tie pin. Accordingly, it is one of the objects of the invention to encapsulate encapsulated droplets of a crystalline liquid in such a way that variations in color in response to variations in temperature will be visible through the body of transparent material in which the encapsulated droplets are in turn encapsulated.

The invention possesses other objects and features of advantage, some of which with the foregoing, will be apparent from the following description of the drawings. It is to be understood, however, that the invention is not limited to the embodiments illustrated and described, as it may be embodied in various forms within the scope of the appended claims.

SUMMARY OF THE INVENTION

In terms of broad inclusion, the invention comprises the further encapsulation of the encapsulated droplets of crystalline material within a transparent body in such a way that the individually encapsulated droplets of crystalline material will still be responsive to variations in temperature to effect iridescence thereof, and so

that the iridescence so formed will be visible to the observer through a transparent body which effectively seals the encapsulated droplets of crystalline material from the ambient atmosphere while permitting transmission of light therethrough.

To this end, in one aspect of the invention, a hollow body of polyester, acrylic or other synthetic resinous transparent material is formed so as to receive therewithin a quantity of the encapsulated droplets of crystalline material, either in unoriented bulk form, or in the form of oriented layers of such encapsulated droplets of crystalline material arranged in strip form. In either case, the quantity of encapsulated droplets of crystalline material is sealed within the recess of the hollow transparent body by a thin layer of polyester, acrylic or other resin, which may or may not be opaque, or some other material, through which heat may be readily transmitted for absorption by the crystalline material.

In another aspect of the invention, the individual beads or droplets of encapsulated crystalline material are applied directly to one side of a flat transparent sheet in the nature of a laminate and to which transparent sheet they are sealed by any appropriate means. In still another aspect of the invention, the flat transparent sheet laminated as described, is further laminated with a like structure so that both sides of the panel constitute transparent surfaces, with the quantity of encapsulated crystalline liquid material being sealed between the two panes of transparent material.

In yet another embodiment of the invention, the transparent body is tubular in conformation and the inner periphery of the tubular body is used as a carrier for the layer or layers of crystalline liquid material encapsulated in individual capsules. Such encapsulated droplets may be sealed to the inner periphery of the transparent tubular body by any appropriate means such as a second tube concentrically disposed therewithin. The second tube may be either opaque or transparent, or may be transparent with an opaque layer on its outer periphery. In either case, the ends of the tubular body are sealed so that the encapsulated crystalline liquid material is isolated from the ambient atmosphere, yet may be subjected to the transmission of heat thereto through the inner periphery of the tubular body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a composite view illustrating use of the invention as the setting for a ring, a bracelet, a pendant, earrings, a tie clasp, and a tie pin.

FIG. 2 is a vertical cross-sectional view through one embodiment of the invention in which the encapsulated crystalline liquid droplets are mounted on a suitable substrate and sealed within a hollow formed in a transparent body.

FIG. 3 is a view similar to FIG. 2, but showing the encapsulated crystalline liquid material filling the recess within a transparent body in the absence of a substrate, and being sealed therein by an appropriate means.

FIG. 4 is a cross-sectional view illustrating a second embodiment in which the encapsulated crystalline liquid material is sealed on one side of a flat transparent sheet.

FIG. 5 is a view similar to FIG. 4, but illustrating formation of a double-faced panel, the separate faces of which are transparent, with the encapsulated crystal-

line liquid material sealed between an intermediary opaque backing member and each associated transparent flat panel.

FIG. 6 is a vertical cross-sectional view similar to FIG. 4, but showing a lamination of two such members in back-to-back relationship so that opposite faces of the composite panel are transparent.

FIG. 7 is a vertical cross-sectional view taken in the plane indicated by the line 7—7 in FIG. 8, and illustrates an embodiment of the invention in conjunction with a tubular transparent body.

FIG. 8 is a vertical cross-sectional view taken along the axis of a tubular transparent body, showing the encapsulated crystalline liquid material forming a layer bonded to the inner peripheral surface of the transparent tubular body.

FIG. 9 illustrates formation of a tubular or toroidal body in the form of a bracelet with the encapsulated crystalline liquid material being bonded to the inner periphery thereof and sealed so as to be isolated from the ambient atmosphere, while placing the encapsulated crystalline liquid material in close proximity to the wearer's body so that body heat may be conducted to the material to effect iridescence thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In terms of greater detail, as explained in the two British patents noted above, one of the problems in connection with mesomorphic cholesterol derivatives in the form of crystalline liquid materials, subject to iridescence through various colors of the spectrum upon application of various temperatures, has been the problem of finding some utility for such crystalline liquid materials. Accordingly, it should be understood in connection with the subject invention that no claim is herein made to the method of effecting polymeric encapsulation of the individual crystalline liquid droplets as disclosed and taught by British Patent 1,138,590, nor is any claim made herein to the use of such cholesteric mesomorphic (liquid crystal) materials in an emulsion of unencapsulated cholesteric mesomorphic material disbursed in a matrix like polymeric binder material as taught in British Patent 1,161,039. Rather, it is the purpose of this invention to describe and claim the utilization in novel combinations to produce novel products of individually encapsulated droplets of temperature-sensitive liquid crystalline material by further encapsulating such encapsulated droplets within a transparent body to form a novel product not heretofore available. It is within the contemplation of this invention that such further encapsulation of encapsulated crystalline liquid droplets may take the form of a laminate in which the encapsulated crystalline liquid droplets are deposited within any preformed hollow transparent body, or it may be carried out by the direct admixture of encapsulated droplets of crystalline liquid material with a liquid polyester, acrylic or other transparent resin in liquid form so that the encapsulated beads of crystalline liquid material are suspended within the liquid phase of the polyester, acrylic or other resin and dispersed throughout such transparent material.

Referring to FIG. 1, in the composite view there shown, to the left thereof, there is illustrated the embodiment of the subject invention as the setting 2 for a ring, or the visible portion 3 of a bracelet. In another form, the invention may be embodied as the setting 4 of a pendant to be worn around the neck, or as the setting 6 for earrings. For men, it is feasible that the invention may be embodied in such useful items as a tie pin 7 or a tie clasp 8.

Embodiment of the invention in different forms is exemplified in FIGS. 2 through 9. Referring specifically to FIG. 2, there is there shown a body 9 of transparent material, conveniently polyester, acrylic or other resin, or a cast transparent material such as glass. The body 9 is formed with a recess defined by the inner surface 12 depressed below the level 13 of a peripheral flange 14. Within the recess thus defined, there is deposited one or more layers 16 of closely spaced encapsulated droplets of crystalline liquid material conveniently caused to adhere to a substrate 17 by any suitable means such as described in British Patent 1,138,590. The substrate, for instance, may be a metal foil, or a non-metal material on one surface of which the encapsulated droplets of crystalline liquid material are caused to adhere to form a cohesive film.

The film thus formed, may be a single layer of encapsulated crystalline liquid droplets, or may be a plurality or multiplicity of layers, with the encapsulated droplets of each of the layers being responsive to different temperatures to produce different color effects. In FIG. 2, there is illustrated a film 16 supported on a substrate 17, with the film being two layers thick. As there shown, the substrate-supported film of encapsulated crystalline liquid droplets are sealed within the recess formed within the transparent body 9 by a sealing member 18, preferably adherent to the opposite side of the substrate 17 from the encapsulated crystalline liquid droplets, and adherent also to the peripheral edge 13 of the flange 14. In this way, the encapsulated crystalline droplets are completely sealed from the ambient atmosphere, and yet are in direct thermoconductive relationship to the substrate 17 and the sealing member 18, so that any variation in temperature may be conducted through the sealing member 18 and substrate 17 to produce iridescence of the encapsulated crystalline liquid material. It will, of course, be apparent that the sealing member 18 may be a metallic or non-metallic member, the requirement being that it form a substantially hermetic seal with the peripheral edge 13 of the flange 14.

Referring to FIG. 3, there is there shown a structure similar to the structure illustrated in FIG. 2, but in which the substrate 17 has been omitted. In this instance, the recess formed within the body 9 is essentially filled with individually encapsulated droplets of the crystalline liquid material which may be in layer form as illustrated in FIG. 3, or which may be indiscriminately oriented one to the other, (i.e., unoriented) within the recess and then sealed therein by the sealing member 18, which again effects a substantially hermetic seal around the peripheral edge 13 of the flange 14 of the transparent body. The advantage of this construction is that the encapsulated droplets of crystalline liquid material may be purchased in bulk form and simply deposited within the recess within the transparent body 9. It will, of course, be obvious that the recess may be of any configuration so that a variation of effects may be visible through the transparent body within which the iridescible droplets of encapsulated crystalline liquid material are sealed.

While FIGS. 2 and 3 are cross-sectional views showing the relationship between the thickness of the transparent body 9 and the disposition of the encapsulated droplets of crystalline liquid material therewithin, it is apparent that the configuration of the body itself in a direction perpendicular to FIGS. 2 and 3 may be of any configuration. For instance, it is contemplated that such transparent body may be ovate, circular, or rectangular, or any other appropriate configuration consistent with the use to which the device when completed will be applied.

It is important also to note that with respect to the conduction of heat to the encapsulated droplets of crystalline liquid material, such thermoconduction progresses more readily through the sealing member 18 and substrate 17, as illustrated in FIG. 2, or directly through the sealing member 18 into the encapsulated droplets directly as indicated in FIG. 3. Transmission of heat energy through the transparent body 9 is in general slower than transmission of heat energy through the opposite side of the device. In general, it may be said that the transparent body 9 functions to conduct light energy as opposed to heat energy. Thus, while heat energy is utilized to effect iridescence of the encapsulated crystalline liquid material, the transmission of light through the body 9 is effective to permit such iridescence to be visible to the naked eye and thus make this quality of iridescence of practical use with respect to novelty devices of this type.

Referring to FIG. 4, the embodiment there shown utilizes a flat transparent face plate or panel 21 against one surface 22 of which a single or multiplicity of layers of encapsulated droplets 23 of a crystalline liquid material are arranged, either indiscriminately oriented, or in layer form as indicated. In this instance, the flat transparent face panel 21 is provided with a peripheral sealing band 24 hermetically sealed by any appropriate means to the edge 26 of the panel 21, and cooperating with a sealing member 27 disposed substantially parallel to the transparent panel and effective to confine the encapsulated droplets of crystalline liquid material in tight contiguous relationship to the surface 22 of the transparent panel.

As with the embodiments illustrated in FIGS. 2 and 3, the sealing member 27 may be metallic or non-metallic, the criterion being that it seal the encapsulated droplets of crystalline liquid material from the ambient atmosphere. In most instances, it is preferable that the sealing member 27 be metallic because of its advantageous thermoconduction characteristics, and also because a metallic sealing member is opaque. Thus, light transmitted through the transparent panel and striking the iridescing droplets of crystalline material will be reflected back through the transparent panel for observation.

In this regard, the peripheral seal flange 24 may be transparent or non-transparent, may be metal or non-metal, but should be compatible in its thermal expansion and contraction characteristics with the panel 21 and seal member 27, to both of which it is secured. In a preferred method of fabrication, if the transparent panel is one of the transparent synthetic resins, such as polyester or acrylic resins, it is preferred that the seal flange 24 also be fabricated from one of these materials. Where the transparent panel is fabricated from glass, the seal flange 24 may likewise be fabricated from glass, but if fabricated from metal, the nature of the union between the edge 26 of the transparent panel and the metallic seal flange 24, including the cross-sectional thickness of the seal flange 24, should be gauged so that there is little or no stress in the union between these two members due to thermal expansion and contraction thereof.

The embodiment of the invention illustrated in FIG. 5 is an expansion of the concept illustrated in FIG. 4. In this embodiment, a second panel 28 has been added to the ordinarily exposed side of the seal member 27', and an additional layer or layers or quantity of indiscriminately oriented individually encapsulated droplets of crystalline material 31 are disposed between the additional transparent panel 28 and the member 27' in the recess 29 in the recess formed therebetween. In this instance, the peripheral seal flange 24' is extended to overlap the peripheral edge 32 of transparent panel 28 so as to completely close the void or recess between the two transparent panels 21 and 28.

It will thus be seen that in this construction the member 27' does not act so much as a sealing member as it does a supporting or backing member for the encapsulated droplets disposed on each side thereof. Additionally, where the member 27' is opaque, as it would be if fabricated from metal, the member 27' performs the function of reflecting light passing through each of the transparent panels 21 and 28 so that the iridescing quality of the encapsulated droplets of crystaline liquid material may be visible through each of the transparent plates.

In this embodiment, it is preferable that the sealing flange 24' be fabricated from a highly thermally conductive metallic material as opposed to a non-metallic material having less thermal conductivity, so that thermal energy absorbed by the sealing flange 24' may be conducted directly to the peripheral edge of the intermediate member 27' and from this intermediate member to the contiguous encapsulated droplets of crystalline liquid material. It will thus be seen that iridescence through variations in color will commence initially in the peripheral margins of the device and gradually diffuse in vari-colored fashion through the entire expanse of the panel.

FIG. 6 illustrates an embodiment which constitutes a lamination of two of the units illustrated in FIG. 4. In the interest of brevity, corresponding reference numbers have been applied to corresponding elements of the combination. It should be noted however, that in this instance, as illustrated in FIG. 6, the sealing flange 24 is preferably fabricated from a metallic material which forms a close bond with the peripheral edge of the intermediate sealing member 27 so that there may be an efficient conduction of thermal energy from the peripheral flange 24 to the associated member 27. In this embodiment, the member 27 in each instance performs a sealing function, with the adjacent members 27 merely being secured one to the other through an appropriate adhesive.

In the embodiment of the invention illustrated in FIGS. 7 and 8, the transparent body 36 constitutes a tubular member, preferably cylindrical in form, and one or more layers 37 of separately encapsulated droplets of crystalline liquid material are disposed contiguous to the inner peripheral surface 38 of the transparent tubular body. As previously discussed, the encapsulated droplets may be in film form, supported by an appropriate backing member 39, which may be a flexible non-

metallic synthetic resinous material such as a polyester or acrylic resin, or a metallic foil on which the encapsulated droplets of crystalline liquid material are deposited to form a film.

This film may be caused to adhere to the inner periphery of the tubular transparent body 36 so that in effect the layer or layers of encapsulated droplets, together with the foil 39 on which they are supported, constitute a lamination bonded to the inner periphery of the tubular transparent body. In another aspect of this invention, the member 39 may be additionally supported by inserting a support member 41 therewithin. The support member 41 may be transparent or non-transparent, may be metallic or non-metallic and where transparent, it is preferable that the member 39 be opaque so as to increase the efficiency with which the light passing through the body 36 and striking the iridescing encapsulated droplets of crystalline liquid material, is reflected back through the transparent tubular body for observation.

As in the previous embodiments, the encapsulated droplets of crystalline liquid material are preferably isolated from the ambient by an appropriate seal member 42 secured across the end edge 43 of the tubular transparent body. Additional support is given the sealing member 42 by a reinforcing member 44. Preferably, the sealing member 42 is also sealingly engaged to the end edge 46 of the inner tubular support member 41 where such support member is used. In terms of utility, such a tubular construction may be useful in a water system, for instance, where it is desirable to monitor the temperature of the water.

Thus, where the inner tubular support member 41 constitutes a hot water conduit, heat from this member will be conducted directly to the foil 39 and thence to the iridescible encapsulated droplets of crystalline liquid material. The degree of thermal energy thus conducted will be apparent to an observer, the color seen by the observer being an indication of the temperature of the liquid passing through the inner conduit 41. In this respect, it will of course be understood, different compositions of crystalline liquid material will produce different colors at various temperatures so that any desirable or convenient combination of colors may be utilized to signify different conditions or temperatures of the water passing through the inner conduit 41.

In another aspect of this invention, and relating primarily to novelty devices as opposed to industrial utilization of the invention, FIG. 9 illustrates a bracelet construction designated generally by the numeral 3, to be worn in the manner indicated in FIG. 1. In this construction, the transparent body 51 is generally toroidal in configuration, the outer peripheral surface 52 being generally circular or ovate in cross section so as to produce a lens effect to magnify the iridescing quality of the separately encapsulated droplets of a crystalline liquid material 53 confined within a recess 54 formed in the inner periphery of the toroidal body.

As indicated heretofore, the encapsulated droplets of crystalline liquid material may be appropriately mounted on a suitable film or foil 56, which may be cut in strip form so as to be accommodated within the recess 54 as shown. For additional support, and to provide direct conduction of thermal energy from the wrist of the person wearing the bracelet, and additionally to render the inner periphery of the bracelet smooth and contribute to the esthetic appeal of the bracelet, a support band 57 is preferably disposed concentrically within the inner periphery of the support film or foil 56 and caused to adhere at its lateral edges to the associated sides of the recess adjacent the inner periphery of the bracelet. In this way, the encapsulated droplets of crystalline material lie confined and hermetically isolated from the ambient atmosphere within the transparent body of the bracelet, where they may be easily subjected to variations in thermal energy so as to produce variations in color responsive to such variations in temperature.

From the foregoing, it will be apparent that the invention may be embodied in many different forms to provide devices of both novelty and industrial application. It should especially be noted that shapes do not limit the uses to which the encapsulated droplets of crystalline liquid material may be put, the concept of further encapsulation of the encapsulated droplets of crystalline material being applicable in many different embodiments within the scope of the appended claims.

Having thus described my invention, what is claimed to be novel and sought to be protected by letters patent is as follows:

1. As an article of manufacture, the combination comprising:
   a. a transparent body;
   b. a multiplicity of separately encapsulated droplets of a crystalline liquid encapsulated in turn within said transparent body, said droplets of separately encapsulated crystalline liquid iridescing when subjected to varying temperatures to display through said transparent body varying colors correlated to said varying temperatures;
   c. said transparent body being generally flat and having a peripheral flange defining a recess within said body, said multiplicity of separately encapsulated droplets of crystalline liquid being deposited within said recess; and
   d. means for sealing said recess whereby said encapsulated droplets of crystalline liquid are sealed within the recess of said transparent body.

2. The combination according to claim 1, in which said means sealing said recess comprises a hardened mass cast in said recess and adherent to said transparent body and to said multiplicity of encapsulated droplets of crystalline liquid.

3. As an article of manufacture, the combination comprising:
   a. a transparent body;
   b. a multiplicity of separately encapsulated droplets of a crystalline liquid encapsulated in turn within said transparent body, said droplets of separately encapsulated crystalline liquid iridescing when subjected to varying temperatures to display through said transparent body varying colors correlated to said varying temperatures;
   c. said transparent body being generally flat and having a recess therewithin, said encapsulated droplets of crystalline liquid being disposed in self-supporting film form and deposited in said recess; and
   d. means superimposed over the film of encapsulated droplets of crystalline liquid to support said film and seal said recess.

4. As an article of manufacture, the combination comprising:

a. a transparent body;

b. a multiplicity of separately encapsulated droplets of a crystalline liquid encapsulated in turn within said transparent body, said droplets of separately encapsulated crystalline liquid iridescing when subjected to varying temperatures to display through said transparent body varying colors correlated to said varying temperatures;

c. said transparent body being tubular in form and having inner and outer peripheral surfaces, said encapsulated droplets of crystalline liquid being disposed in a layer adjacent the inner peripheral surface of said tubular transparent body; and

d. means superimposed over the layer of encapsulated droplets of crystalline liquid to seal the encapsulated droplets against the inner peripheral surface of the tubular transparent body.

5. The combination according to claim 4, in which said means superimposed over said layer of encapsulated droplets of crystalline material comprises a tubular member.

6. As an article of manufacture, the combination comprising:

a. a transparent body;

b. a multiplicity of separately encapsulated droplets of a crystalline liquid encapsulated in turn within said transparent body, said droplets of separately encapsulated crystalline liquid iridescing when subjected to varying temperatures to display through said transparent body varying colors correlated to said varying temperatures;

c. said transparent body comprising a flat sheet, said encapsulated droplets of crystalline liquid are disposed in a layer on one surface of said flat transparent sheet;

d. a flat opaque backing member superimposed coextensively over said layer of encapsulated droplets;

e. means sealing marginal edge portions of said flat opaque backing member to said flat transparent sheet to enclose and support said encapsulated droplets between said flat transparent sheet and the flat backing member;

f. a second layer of encapsulated droplets of crystalline liquid disposed on the other side of said flat opaque backing member from said first layer of encapsulated droplets of crystalline liquid; and

g. a second transparent flat sheet disposed over said second layer of encapsulated droplets of crystalline liquid material, said marginal sealing means sealing marginal edges of both said transparent sheets and the intervening flat opaque backing member.

7. As an article of manufacture, the combination comprising:

a. a transparent body:

b. a multiplicity of separately encapsulated droplets of a crystalline liquid encapsulated in turn within said transparent body, said droplets of separately encapsulated crystalline liquid iridescing when subjected to varying temperatures to display through said transparent body varying colors correlated to said varying temperatures;

c. said transparent body comprising a flat sheet, said encapsulated droplets of crystalline liquid are disposed in a layer on one surface of said flat transparent sheet;

d. a flat opaque backing member superimposed coextensively over said layer of encapsulated droplets;

e. means sealing marginal edge portions of said flat opaque backing member to said flat transparent sheet to enclose and support said encapsulated droplets between said flat transparent sheet and the flat backing member;

f. a second assembly including a transparent flat sheet, a layer of encapsulated droplets of crystalline liquid, and a flat opaque backing member mounted on said first assembly, said flat opaque backing members lying in close juxtaposed relation; and

g. adhesive means securing said backing members to each other.

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